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REVIEW DRAFT

STUDY PLAN II-85-1
LONG TERM EFFECTS OF PRESCRIBED FIRE ON THE PRODUCTIVITY OF BLM LANDS IN WESTERN OREGON

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INTRODUCTION

Much concern has been expressed lately about the effects of present day management practices on long term forest productivity. The BLM's western Oregon research committee is addressing this issue in part by approving studies of ecosystem nutrients and forest compaction changes resulting from intensive management. One major concern identified by BLM western Oregon soil scientists is the effect of prescribed fire upon the long term nutrient capital of the forest.

Existing literature on effects of prescribed fires is voluminous. Models exist to predict fuel loading, fire behavior, and immediate fire effects in terms of consumption of woody fuel and forest floor (Sandberg and Ottmar 1983; Sandberg 1980). Very little work, however, has been done to assess the changes in the total nutrient capital as a function of fire effects on various soils with inherent differences in nutrient reserves.

Kimmins and Scoullar (1979) have developed a simulator of coniferous stands (FORCYTE) which can show the effects of various harvest and site preparation upon productivity in future rotations. The usefullness of this model for specific, local purposes depends on the input of accurate growth and yield, nutrient capital, and cycling data obtained locally. FORCYTE is a framework for evaluating long term effects of management practices. Data generated from this study will be used in aiding the validation of FORCYTE 11 for soils with various nitrogen reserves.

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This research will determine the effect of prescribed fire on site nitrogen capital, survival and growth of seedlings, and competing vegetation. Plot layout will provide sites for future studies to assess the long term effects of prescribed fire on site productivity.

PREVIOUS WORK

The study of fire and fire effects has produced extensive bibliographies and reviews (Feller 1982; Evans 1979; Wells et al., 1979; Raison 1979). However, the ecosystems studied, the types of fire involved and the environmental conditions preceeding the fire are nearly as numerous as the studies. Thus, while some general effects of fire may be inferred, interpreting fire effects for a specific ecosystem will remain imprecise until that system is studied in detail.

Past research on fire in the Pacific Northwest has concentrated on the impacts of wildfire (Grier 1975) or on burning heavy logging slash when utilization standards were much lower than today (Isaac and Hopkins 1937; Morris 1970; Dyrness et al. 1957). These fires were very intense, consuming most of the slash and duff and often part of the organic matter in the surface soil. As a result, nutrient cycling processes, particularly the nitrogen cycle, were seriously disrupted. Recent evidence indicates that the sulfur cycles are also impaired (Tiedemann and Anderson 1980; Nissley 1980).

Concern for the effects of intense slash fires on the soil resource was voiced over forty years ago (Isaac and Hopkins 1937) and recommendations for reducing fire intensity were suggested nearly thirty years ago (Youngberg 1953). Today, in western Oregon, fire is prescribed under much more favorable conditions. Current research of immediate fire effects by the Residue and Energy Program, Pacific Northwest Forest and Range Exp. Sta. has led to the potential to reduce those effects drastically. Duff consumption can be predicted from fuel consumption (Sandberg 1980).[1] Fuel consumption can be predicted from fuel moisture, which is monitored by remote weather stations (Ottmar and Sandberg 1983). Moderate duff consumption (less than 1.5 inches consumed) can be acheived when fuel moistures are greater than 23%. When duff consumption and fuel consumption are reduced, so are emissions from the burn (Ward 1983). Therefore, fuel managers have the ability to avoid the drastic effects of the high intensity burns of the past by prescribed fire under favorable moisture conditions. Consequent effects on productivity will be more subtle. With a good monitoring system which covers the range of site variables, we may provide managers with tools to predict the effects of fire on productivity and design treatments which protect nutrient capital while acheiving objectives of timely site preparation and reforestation.

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1. Ottmar, Roger D.; Little, Susan N.; Ohmann, Janet L. Clearcut slash burning and duff reduction in the Douglas-fir region of western Oregon. Manuscript on file with the Forest Residue and Energy Program, Seattle, WA.

Competing vegetation has been responsible for many plantation failures on both BLM and Forest Service lands. Since herbicides are no longer an option in Oregon and hand labor is price prohibitive, prescribed fire one of the few tools that fuel managers have to control competing vegetation. Unfortunately, little research has been done to quantify the relationship between fire behavior and control of vegetation on steep slopes. Long term monitoring of sites across a range of brush species which are burned within present management guidelines will enable us to evaluate the effectiveness of moderate burning to control vegetation.

The effects of competing vegetation cannot be ignored when determining the effect of prescribed fire on site productivity. In some cases, prescribed fire can set back competing vegetation, giving the seedlings an edge over their noburn counterparts. This advantage may overshadow the loss of nutrients from burning. In other situations, fire may enhance the ability of a brush species to inhabit the site, compounding the effects of nutrient loss on productivity.

Although there has been research on the effects of fire on competing vegetation in the Northwest since the 1930's, many of these studies were conducted on only one site with no replication. Much of the work done before the 1970's was done at a time when the objective of burning was to burn hot and clean, consuming most of the organic matter. In subsequent research, the nature of the fire was ill-defined, making application of the results to current practices difficult.

Morris (1970) began an extensive survey of fire effects in 1946. Sixty-two pairs of burn/noburn plots were established in western Washington and Oregon over a range of soil types, tree species, and amounts of residue before burn. Levels of burn were described by visual observations of fuel and duff consumption. Some plots were planted with several species, some were naturally seeded. After 14 years, some plots were fully stocked with commercial species, while others were virtually unstocked. Plots were revisited in 1975 (Kraemer and Hermann 1979). After 25 years, no statistical difference in soil properties between burn and unburned samples was detected on the 26 plots in Southern Oregon. Since the data were averaged for all sites, with few samples taken in each plot (only 2 for the unburned plots) and no pre-burn soil data exists, this lack of significance may reflect inadequate sample size within plots, or high variability in soil characteristics within or between plot pairs before burning. Without information on pre-burn soil characteristics and fire behavior, it is difficult to relate the study results to current prescription practices. This work has highlighted the need to control management activities on long-term study areas and to treat all study areas uniformly.

OBJECTIVES

The over all objective of this study is to define the range of effects that moderate prescribed burns will have on the long term productivity of sites in western Oregon which the BLM has identified as most likely to be damaged from prescribed burning. These sites are broadly characterized as having a southerly aspect, thin duff layer, and shallow or skeletal soils. We have chosen to study the effects of moderate burns to reflect current management practices. Three sites will be selected on each of five Districts: Coos Bay, Roseburg, Medford, Eugene, and Salem. Sites will be chosen to cover the range of sites with low resilience to nutrient loss from prescribed fire.

For the sites chosen on each District the following objectives will be met:

1) Determine the amount of nitrogen and organic matter lost by prescribed fire as it relates to the total nutrient capital.

2) Determine if the composition and cover of non-coniferous vegetation is significantly different within the first 2 years after burning from adjacent sites which have not been burned.

3) Determine if survival and growth of planted seedlings are significantly different within the first 5 years between burned and the adjacent unburned sites.

Study design will allow for long term monitoring of tree growth on these sites. Data from the study sites will support the evaluation of long-term consequences of prescribed fire using FORCYTE.

JUSTIFICATION

Federal legislation and subsequent regulations dictate that Federal agencies will evaluate the environmental impacts of forest management practices and that those practices will not impair the long-term productivity of the land. In recent decisions, the courts have interpreted these laws in the strictest sense, and the burden of proof has been put on the government to determine the impacts of their management practices. Although "worst case" analyses have not been mandated for each management decision, it behooves Federal agencies to conduct scientifically sound analyses of the impacts of forest practices on long term productivity.

The effects of prescribed fire on productivity involves not only the losses of important nutrients during the burn, but also losses incurred later through erosion and leaching. Current restrictions on the use of herbicides has lead to an increasing dependence on prescribed fire to control competing vegetation. In some cases, the objectives of fuel reduction and vegetation control can be acheived without significant losses of site nutrients. In other cases, there is a tradeoff between nutrient retention and vegetation management. This study will determine the range of effects of fire on nutrient capital, competing vegetation, and seedling survival and growth on sensitive sites.

METHODS

This section will describe the overall study design. Detailed instructions for data collection and tally sheets are in the Appendix. An attempt was made to keep the methods simple in light of the number of people involved in data collection and the likelihood of personnel changes in the next six years. This may sacrifice some precision, but will ensure consistency in data collection over the years and between the Districts.

Site selection - The study sites will be selected from conifer units currently planned for burning. Three sites of similar site quality, soil type, species composition and fuel loading will be selected on each of the five western Oregon Districts. One site per District will be burned in 1985; the other two will be burned in 1986.

Plot layout - An unburned control, protected by firelines, will be established within the unit. The location and size of the control will be selected to minimize soil and site variability between burned and unburned plots and to reduce the risk of escape fires in the control. The minimum size of each treatment area will be 2 ha. Treatment areas should be buffered from the edge of the unit and each other by at least 30 m to avoid any edge effect.

27 plots with 2-m radius will be established on the burn and on the control areas of each unit (figure 1). Plots will be located on a grid to aid in relocation and minimize disturbance by crews. Plot centers will be marked with a 5 ft. metal pole tagged with a numbered disk. All site variables pertaining to small diameter fuel, herbaceous vegetation, and soils will be sampled within these plots. The configuration of a plot is diagrammed in figure 2. Large fuels, shrubs, and exposure of mineral soil will be measured by the line intersect method, with lines originating at plot centers.

Measuring woody fuels - To ensure compatibility with previous research, fuel will be grouped into timelag fuel classes for measurement. All diameters will be measured outside bark. Fuels will be inventoried by the planar intersect technique along segments of perpendicular planes randomly oriented and intersecting at the plot center (Brown 1974). Diameters of fuels larger than 7.6 cm in diameter will be measured where they intersect four 12.5 m transects at each plot. Diameters of 2.5-7.6 cm fuels will be measured for the first four pieces which are intersected to determine quadratic mean diameter. Intersected pieces (2.5-7.6 cm) will be counted on the first 6 m of line. Fuels 0-2.5 cm will be counted on the first meter of line, with the first four measured for diameter. Based on data at the PNW station taken in Oregon, this will give estimates of fuel loading with standard deviations within 20 percent of the mean.

The 1 m and 2 m points of each transect will be marked with surveyor's flags before and after burn to aid in remeasurement. Forty preburn samples of fuel larger than 7.5 cm will be taken just prior to ignition for moisture determination. These will be taken from across the treatment area but not along the transects. Another set of samples (20 for each of three diameter classes (0-1 in., 1-3 in., 3+ in.) will be taken for nutrient determination.

Fuels will be reinventoried after burning to estimate fuel consumption by size class. Remeasurement of fuels after 2 and 5 years on both burned and unburned plots will provide estimates of the effects of the fire on subsequest fuel accretion.

Measuring duff and soil - At each sampling time, duff loadings will be determined on one quadrat per plot, each 30 by 60 cm, adjusted for slope, located 2 m from each plot center. Duff depth will be measured at 15 locations within the quadrat to determine density. Duff will be removed to mineral soil, weighed, air-dried, weighed, and ground to pass a 20-mesh screen.

Soil samples will be collected from the 0-5, 5-15, and 15-30 cm depths at four locations on each plot for nutrient analyses. These samples will be air-dried. Bulk density samples will be taken for each depth at twelve locations diagonally across the unit. These sampling points will not coincide with other sampling spots. Samples will be oven dried at 105°C, weighed, sieved to 2mm. The coarse fragments will be weighed, and their volumes estimated by water displacement. The weight and volume of fine soil by difference, will be used to calculate bulk density.

Soil and duff samples will be composited in groups of three plots into nine samples for nutrient analyses: one from plots 1-3, one from plots 4-6, one form plots 7-9, etc. The composite samples will be analysed for total nitrogen (Kauffman and Gardner 1976) and organic matter. Total nutrient quantity will be determined from soil test data and bulk density measurements, corrected for coarse fragment contents taken within each plot. Remeasurement of soil will occur immediately after the burn and at 1-, 2-, and 5 years following the burn at the same locations where duff is sampled.

Percent mineral soil exposure will be inventoried by the line intersect method along the fuel transects as described by Howes, Hazard and Geist (1983).

Measuring herbaceous vegetation - Cover and loading of herbaceous vegetation will be estimated on the same 30 by 60 cm quadrats used for sampling duff. Average height and percent cover of all herbaceous vegetation will be estimated on each of the four quadrats per sampling point (Brown and Marsden 1976). On the same quadrat destructively sampled for duff, herbaceous vegetation will be clipped, dried at 70°C and weighed.

Measuring shrubs - Live shrubs will be inventoried on the large fuel transects according to methods described by Canfield (1941). Area of crown cover will be estimated by species before burning and at 1-, 2-, and 5 years after burning.

Treatment of unit - The study unit will be prepared for burning under existing organizational guidelines. The only exception to standard operating prodcedures will be that a portion of the harvest unit will be protected by a fire line as an unburned control. The unit will be broadcast burned under prescription set by the research team on the District.

Quantifying fire behavior - Fire weather, fuel moisture, visual and photo observation will be used to document fire behavior. Emphasis will be placed on observing the fire as it crosses each row of plots. Air temperature, relative humidity, and precipitation will measured near each burn unit daily until the day of the burn. Flame length and duration will be measured using 3 m marked poles placed at the end of each row of plots.

Measuring survival and growth of seedlings - Eight seedlings, 2 rows of 4 each, will be permenently marked near each grid point. Care will be taken to avoid planting in areas where duff and soil have been or will be sampled. Seedlings will be measured for height and caliper and protected from browsing with Vexar ^{R} tubes. Survival, heights and basal diameters will be measured 1-, 2-, and 5-years after planting.

DATA ANALYSES

The Student's t will be used to test for differences between burned and unburned treatments on each site for seedling survival and growth, fuel loadings, competing vegetation, and changes in soil nutrients. An analysis of variance will be conducted for the three sites on each Disctict for the same variables. For this analysis of variance, each unit will be considered a block with two treatments, with 27 samples per treatment for woody fuel, vegetation, seedling growth and survival, and mineral soil exposure. Because we are compositing samples from groups of three plots for nutrient analyses, the number of samples per treatment will be 9 for nitrogen and carbon loss.

Analysis of Variance Table

	degrees of freedom	
Source	fuel, exposure, vegetation	nitrogen and carbon loss
Blocks	2	2
Treatment	1	1
Experimental Error	2	2
Sampling Error	162	48
Total	167	53

RESPONSIBILITIES AND SCHEDULE

This project will begin in February 1985, with a tentative completion date of September 1989. By that date, the short term results can be published. The study procedures are designed to provide plots for the long-term study of fire effects with an extended time frame, if appropriate.

The personnel who will be involved directly in field work will be one soil scientist, one fuel specialist, and one silviculturalist from each District. Field duties will be assigned according to District Manager's priorities, but it is suggested that the soil scientist lay out plots & take soil samples, the fuel specialist take charge of fuel measurements, the burn, and protection of control area, and the silviculturalist measure plant variables.

An orientation and training session lasting two days will be held for all District personnel involved in the study. These employees will meet for one day each fall and spring thereafter to assess progress to date, troubleshoot and share experiences. The authors will initiate all such meetings.

Schedule of Activities

Activity	Duration
Orientation & training of District personnel	2/85
Selection of sites	2/85-5/85
Establishment of plots	4/85-6/85
Seedlings, shrubs and fuels measurements (post-fire)	4/86-12/88
Completion of initial effects on fire on fuels	2/87
Two years seedling survival and growth	9/89
Two year effects of fire on soil resource	9/89
FORCYTE evaluations	88/89
Summary of fire effects	12/91

Layout of plots and before, during and after monitoring of the site will require approximately 3 person-months the first year for each unit. Second year monitoring will require 1 person-month and remeasurements after 3 and 5 years will require approximately 1.5 person-months each.

Soil and plant analysis will be performed by the OSU Department of Forest Science. Statistical analysis will be performed by the authors. All data forms will be kept on file with the Forest Residue and Energy Program, Pacific Northwest Forest and Range Experiment Station, Portland OR with copies held in the BLM State Office.

BUDGET

(in $1000)

	FY'85	FY'86	FY'87	FY'88	FY'89	FY'90	FY'91
Equipment/Supplies	1.2	2.0	0.5	0.3	0.2	0.2	0.4
Chemical analyses	17.0	41.0	32.5	21.7	0.0	10.8	21.6
Data processing	0.0	1.3	2.5	1.5	2.0	4.0	4.0
Travel	2.0	1.5	.5	.5	.5	.5	.5
TOTAL	20.0	45.8	36.0	24.0	2.7	15.5	26.5

This budget includes all USFS expenses to be paid by the BLM. It does not include salaries or travel of BLM employees. USFS and Oregon State University are providing the salaries of the principal investigators. Costs of publications will be covered by USFS.

COOPERATION

Study plots will be located BLM Districts Salem, Eugene, Roseburg, Coosbay & Medford. District personnel will provide the site, protect the unburned portion of the unit, coordinate burning schedule, plant the site with their own stock, and agree not to conduct any other management activity on the site for 10 years without approval from principal investigators.

HEALTH AND SAFETY

See attached F-6700-7.

ENVIRONMENTAL IMPACTS

Destructive sampling for nutrient loss data will not have any impacts beyond those stated in the impact statement for the sale and site preparation.

APPLICATION

The results of this study will provide information necessary for effective fuel management in the Pacific Northwest. Soil profile and chemical description of the sites will be published as a Research Note. Analyses of immediate effects of fire on site capital, competing vegetation and seedling growth and survival will be published in a technical journal, preferrably Forest Science, Canadian Journal of Forest Research, or Ecology and a PNW Research Paper.

Research results and management implications will be transferred at the Forest Service R6 Silviculture Institute held at OSU and other training and seminar opportunities as they arise.

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APPENDIX 1: FIELD INSTRUCTIONS AND DATA FORMS

Field instructions are divided into sections by procedure. Fuel, crown cover and exposure of mineral soil are inventoried by the line intersect method. Herbaceous vegetation, duff and soil are sampled within 2.5 m of plot center. Seedling survival and growth are sampled independently of the other variables. In each case, sampling is more efficient with two people. Three people can be used for fuel and shrub inventory. Each of the three procedures should take no more than one day per site to complete.

SCHEDULE FOR SAMPLING

Year of the burn:

Anytime: unit and plot layout.

One to two weeks before burn: fuel, shrub, and soil exposure inventory, soil sampling for nutrient determination and soil bulk density samples

One day before burn: herbaceous and duff samples

No more than two hours before burn: fuel and duff moistures

Day after burn: fuel and soil exposure inventory, duff and soil samples

Year 1:

At time of planting: tag and record seedlings for growth study

At dormancy (vegetative growth on shrubs has ceased):

herbaceous, duff, and soil samples,

shrub and soil exposure inventory

Years 2 & 5 (At time of dormancy for shrubs):

Growth and survival of seedlings

Shrub, fuel, and soil exposure inventory

Herbaceous, duff, and soil samples

PLOT LAYOUT

Two areas of similar slope, position on slope, aspect, soil, fuel loading and cover must be marked off on each site. Each area should be no less than two acres in size. The no-burn area should be located in a defensible position and protected by firelines dug before plot layout. Both areas should be at least 30 m from roads, piles of residue, or standing timber. Be sure that the two area receive the same amount of exposure to sunlight. Mark the corners of each area with 2 plot poles at each corner and establish permanent markers along the road.

27 plots in each area will be laid out on a grid of equilateral triangles. From the first stump encountered when entering the area, procede into the area 14 m on a random azimuth. Random azimuths can be obtained from the second hand of your watch translating the time into compass degrees (Figure 3). If the azimuth puts you outside the area, add 90^{o} to it until the azimuth heads into the area. Place a plot pole at the 14 m point. Starting at the first pole, place the rest of the poles at 60^{o} angles from the azimuth and 15 m apart from each other. After all the poles have been placed, number them sequentially from the top of the unit (Figure 1).

FUEL, SHRUB, AND SOIL EXPOSURE INVENTORY

Fuel, shrubs, and soil exposure will be inventoried by the line intersect method. Before heading into the field, read up on Brown (1974), Canfield (1941) and Howes et al (1983). Figures 4 and 5 illustrate the methods to be used.

At each plot select a random azimuth (Az) from watch or table. You will lay out 12.5 m of line from the pole along that Az and at Az+90, Az+180, and Az+270. To lessen the confusion in remeasurement, select the azimuth of those four which points uphill, and record that azimuth on the tally sheet as the first azimuth on the plot (AZ). The second would be AZ+90^{o}, etc.

For each line, one person will remain at the plot pole to record data while the other runs the transect and makes the measurements. Run a cloth tape 12 m (correcting for slope) from the plot pole along AZ. As you proceed away from the plot pole, tell the recorder the sections on the tape where shrubs are crossed, and the species of the shrub. (eg. 2.5 m 3.0 m Ceonothus would mean that .5 m of a Ceonothus shrub was intersected by the line.)

At the end of 12.5 m (correcting for slope), drop the tape and return along the line to the plot pole. On the way back, tell the recoder the diameter at intersection and the species of all woody residue greater than 7.6 cm that cross the line. While the recorder is counting the fuel 0-2.5 cm on the first meter of line, count the number of pieces between 2.5 and 7.6 cm that intersect the first 6 m of line. No identification of species is required for the counts. Mark the 1 m point of the line with a surveyor's flag. Return along the transect and record where the tape intersects mineral soil. On the AZ transect only, record the diameters of the first four pieces 2.5-7.6 cm in diameter and the first four pieces 0-2.4 cm in diameter that cross the line.

HERBACEOUS VEGETATION, DUFF, AND SOIL SAMPLING

Sampling herbaceous vegetation - Establish the quadrat on each plot as illustrated in Figure 2. Each quadrat will be 2 m from plot center half-way between fuel transects except the before burn, which will be 1 m away from the after burn quadrat. On the first quadrat (AZ+45^{o}), clip all herbaceous vegetation, and bag by species. Each bag should be labeled with: unit name, burn or noburn, sampling time (before burn, after burn, yr 1,2, or 5), plot #, and species. These bags should be kept in a cool, shady place until brought into the lab.

Sampling duff - Remove all duff on the same quadrat. Bag and label as with herbaceaous sample. Again, these bags should be kept in a cool, shady place until brought into the lab. Measure and record duff depth at the points indicated in figure 6. Depths should be measured to the nearest mm.

SEEDLING SURVIVAL AND GROWTH

Within two weeks of planting, identify the eight seedlings closest to each plot. Be sure to select those seedlings which are not planted in a duff or soil sample location. Mark each seedling with a wire stake and numbered tag.

At years 1, 2 and 5, measure seedling basal diameter to the nearest mm at 3 cm above the ground and height to the nearest cm. Sampling of all vegetation on all units should be done the during the same week of each year at time of dormancy for shrubs.

APPENDIX 2: LAB PROCEDURES

Some tasks require immediate attention after samples are brought in from the field; others can wait. Follow the schedule below:

Within one day of sampling: Lay out all herbaceous, duff, and soil samples to air dry for two weeks in a clean, dry place. Lay out the samples on individual sheets of butcher paper such that samples are piled no more than one inch deep.

Within two days of sampling: Moisture samples must be kept in 4 mil ziplock bags until ready for drying. Weigh all moisture samples and record weight to nearest gram. After wet weights are obtained, samples can be left in containers for up to two weeks before placing in ovens, if they are kept in a dark, dry place. Oven dry woody fuel samples at 105^{o} C for 24 hours; all duff samples at 72^{o} C for 72 hours. After drying, record weights to nearest gram.

After air-dried samples have been dried: Bag and record dry weights of the samples. Duff and soil samples will be sent to PNW for further processing. Be sure that all samples are fully labeled. Duff samples will be ground to pass a 20 mesh screen and then composited. Soil samples will be sieved to separate out coarse fragments and the less than 2 cm particles weighed and composited. Soil and duff samples will be composited in groups of three plots to form nine samples for nutrient analyses: one from plots 1-3, one from plots 4-6, one form plots 7-9, etc. Woody samples will be chipped to 5 mm, then ground.

Bulk density samples will be oven dried at 105°C, weighed, sieved to 2mm. The coarse fragments will be weighed, and their volumes estimated by water displacement. The weight and volume of fine soil. by difference, will be used to calculate bulk density.

EQUIPMENT LIST FOR PRODUCTIVITY STUDY

This list outlines some of the equipment needed to set up and collect pre- and postburn samples for three cutting units (two sampling areas per unit).

40 10ft. lengths of 1/2" steel conduit (thin walled) cut in half (@ $10.20 ea)

250 12"x18" ziplock bags 4mil (@ $110/1000)

800 12x12 ziplocks 4 mil

3000 surveyors flags

1600 numbered tags and wires (81 made of steel)

30 cm x 60 cm frame for sampling duff

buckets

trowels

shovels

bulk density sampler

compass, loggerstape(metric), clinometer

calipers (metric)

drying oven

scale to nearest 0.1 g

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

SAFETY AND HEALTH HAZARD ANALYSIS

(Instructions on back and reference FSM 6740)

1. Identify Job or Project to be Analyzed	2. Location	3. Next Higher Level of Organization
Study PNW 2107-83-1-III	PORTLAND, OR	PROGRAM MANAGER

4. Name of Analyst	5. Job Title of Analyst	6. Date Prepared
SUSAN N. LITTLE	RESEARCH FORESTER	11/1/82

7. Sequential Steps	8. Hazards	9. Factors (a) Consequence	(b) Exposure	(c) Probability	(d) Urgency	(e) Risk Factor	10. Action to Eliminate Hazard (Specify if personal protective equipment (PPE) is required – kind, type, and cost. PPE may be purchased if score is 25+.)
DRIVING ON LOGGING ROADS	1a, b; 4b	35	5	5	0	45	TRAINING IN backroad driving for all personnel
Lifting heavy material	1d	10	5	1	0	16	Familiarize crew with FSH 6709.11 guidelines
Walking over rough terrain	1a, b, c	9	10	5	0	24	
Working in/around fire	4b	15	10	5	0	30	Proper clothing (boots, gloves, hard hat, nomex where needed) will be worn in the field. Initial training in safety will be followed by "tail-gate" safety sessions on each trip + before each burn.

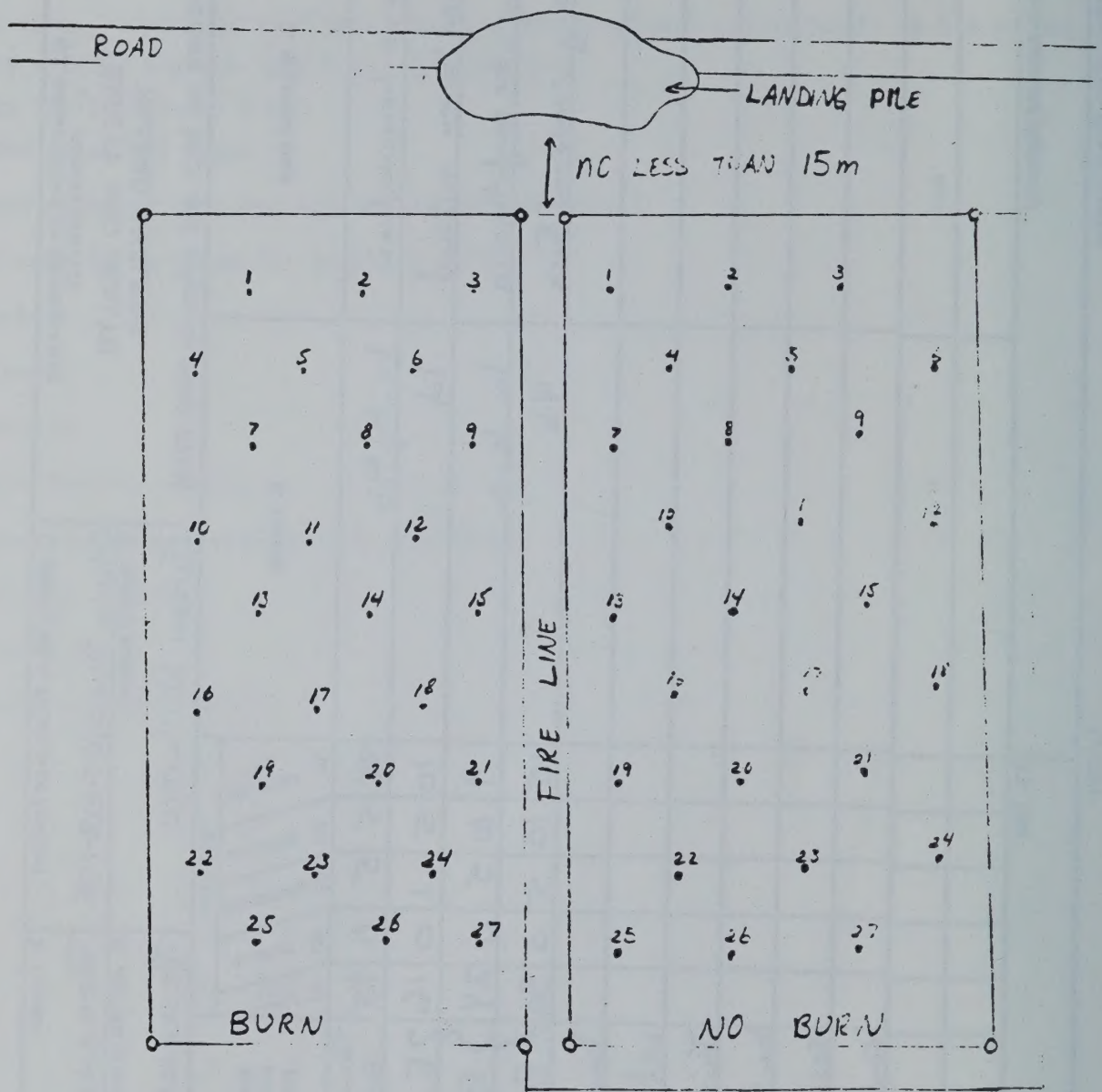
11. Analysis Approved (Signature)	12. Title	13. Date

edition of this form is obsolete.

(-73B)

(6.37 [illegible])

FIGURE 1: APPROXIMATE * LAYOUT OF SAMPLING UNITS WITHIN A CLEARCUT.

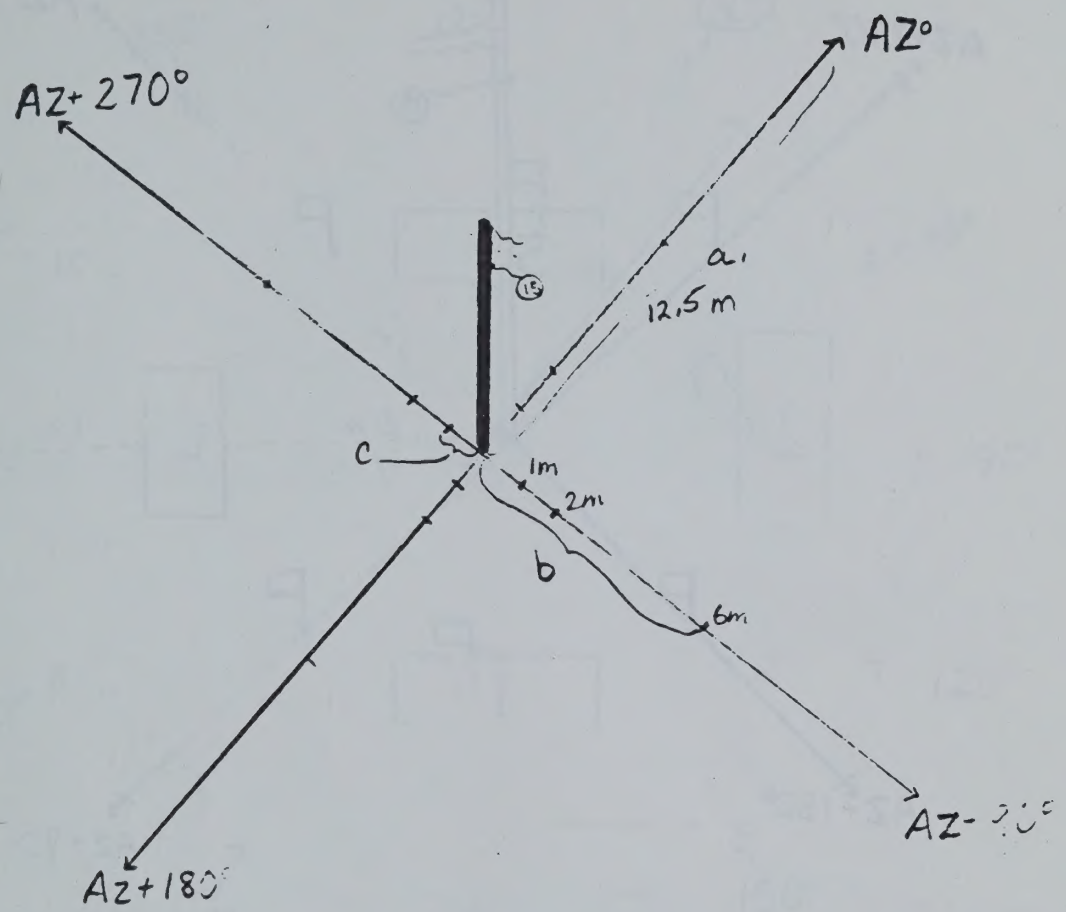


- Plot center marked with 1.5m pole
- Area corners marked with two poles.

* Length and width may vary depending on unit configuration. Number of plots per line will depend on width of area. Area should be approx. 2 acres in size. (90×90m, or 60×120m.)

FIGURE 2: CONFIGURATION OF PLOT

2a. Fuel and shrub transects.

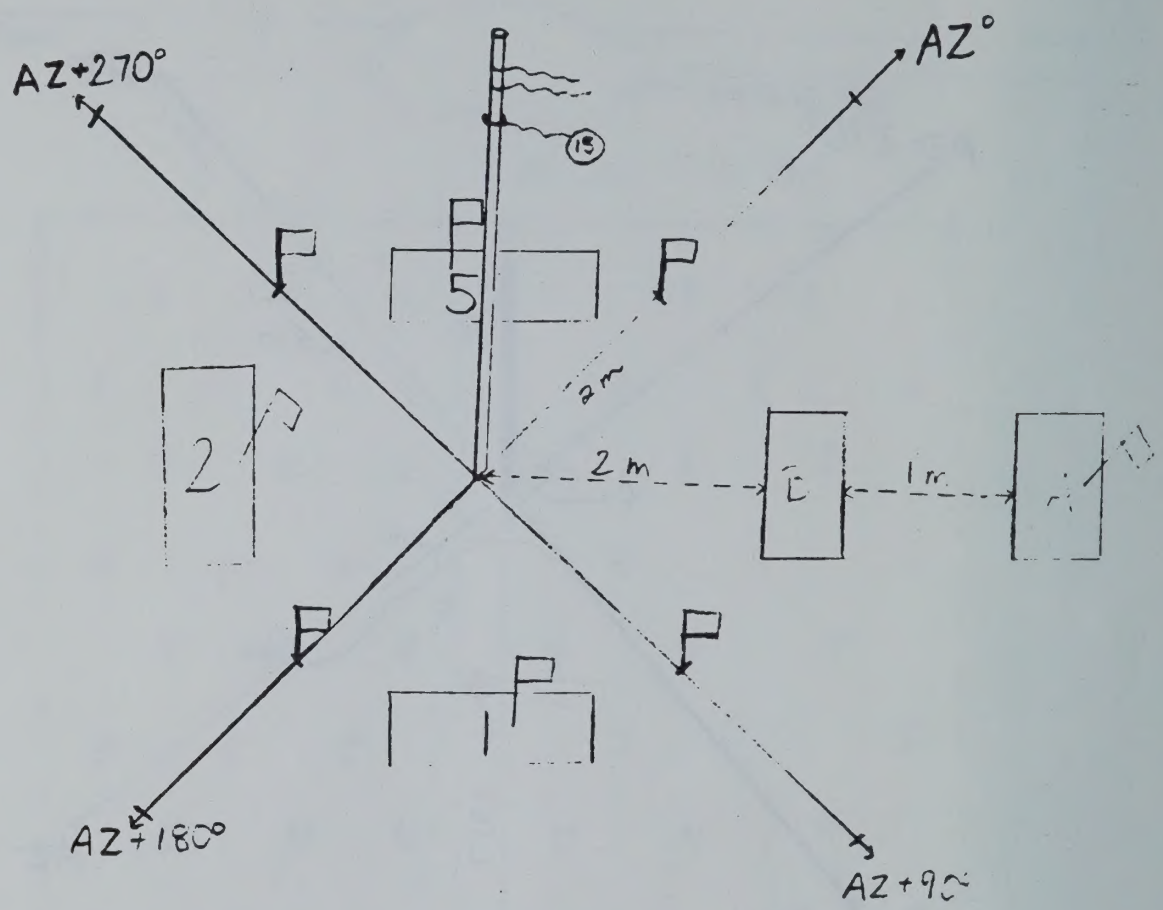


a. 12.5m transect for inventory of shrub + fuel > 7.6 cm

b. 6m transect for count of fuel 2.5 - 7.6 cm

c. 1m transect for counting 0-2.5 cm fuel.

2b. Herbaceous vegetation, duff and soil.

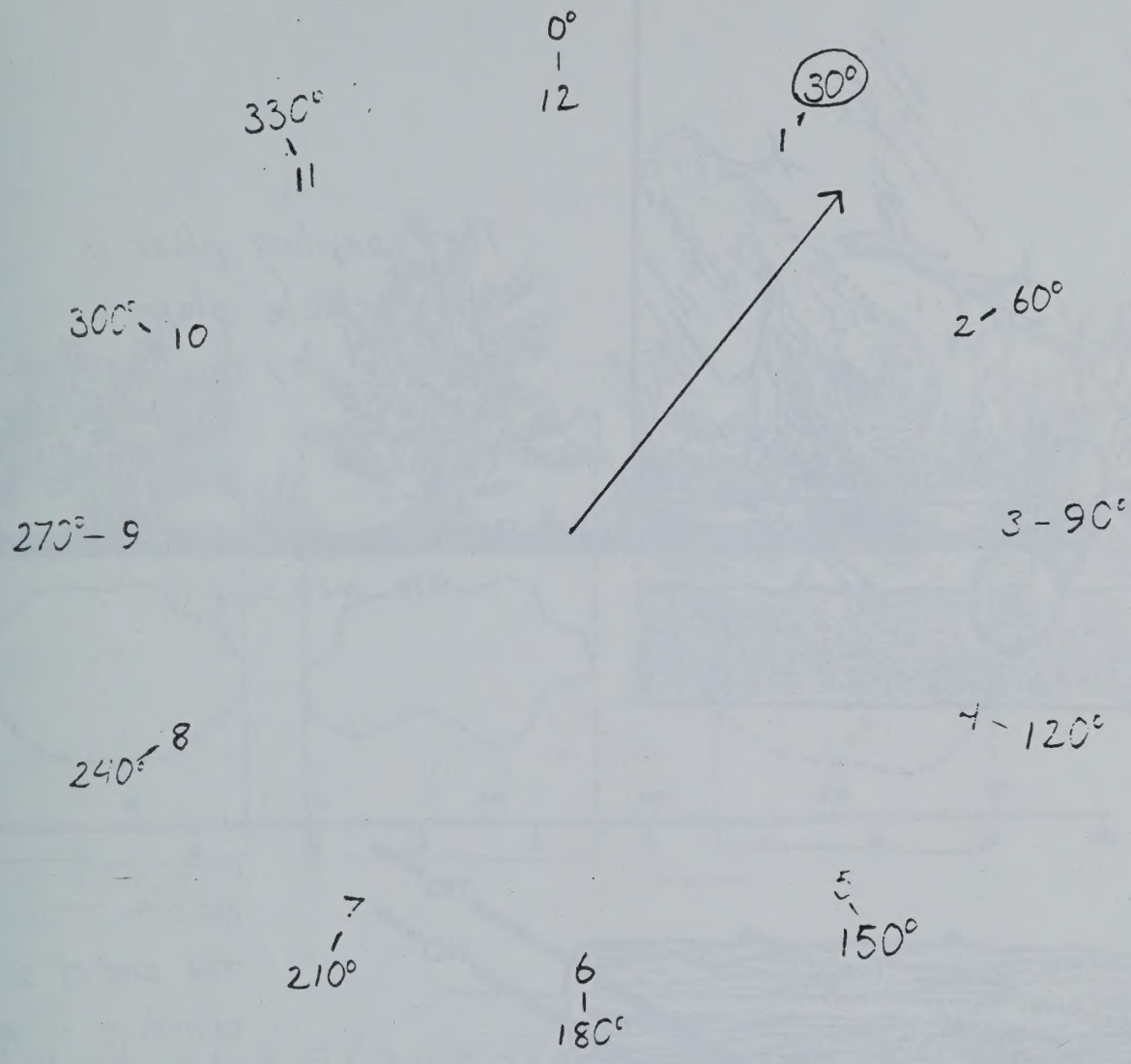


F mark 2m on transects with surveyor's flag

B, A, 1, 2, 5, - quadrats sampled before burn (B), after burn (A), and at years 1, 2, or 5

Mark quadrats A, 1, 2, and 5 with surveyor's flag.

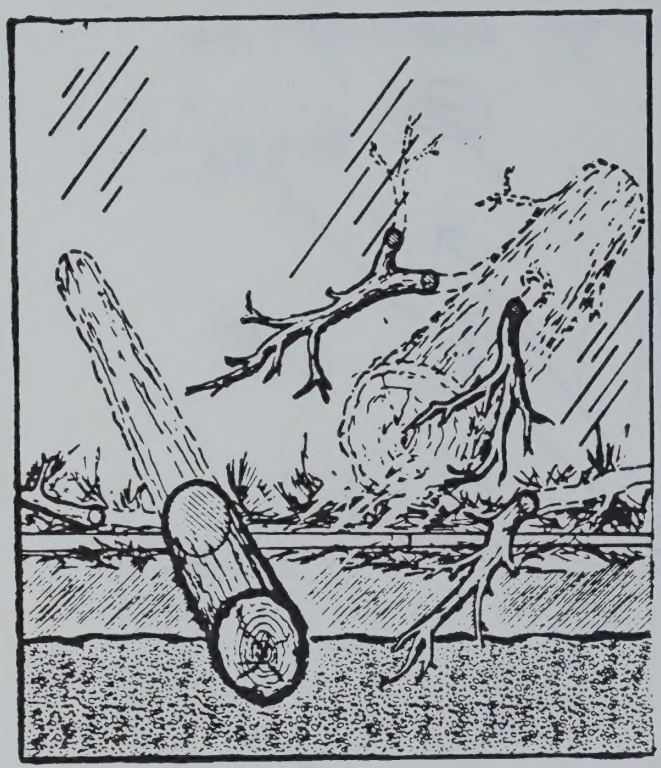
FIGURE 3: RANDOM AZ FROM SECOND HAND ON WATCH.
(Round to nearest 30°)



Digital

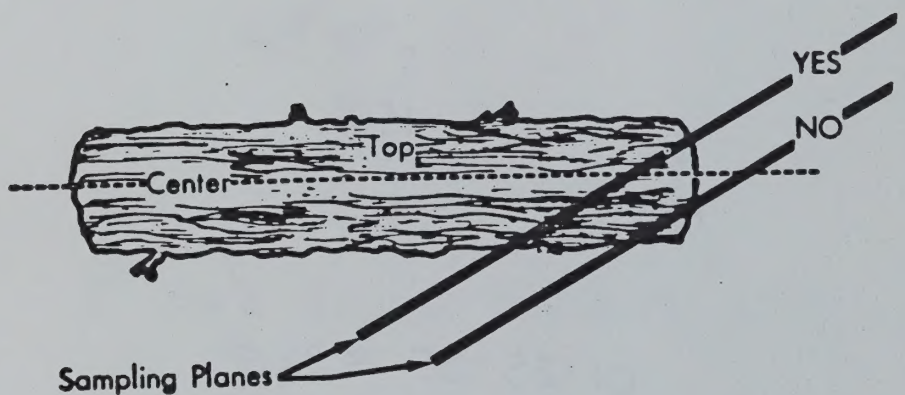
01:25:05 = 30°
:10 = 60°
:15 = 90°
:20 = 120°
:25 = 150°
:30 = 180°
01:25:35 = 210°
:40 = 240°
:45 = 270°
:50 = 300°
:55 = 330°
01:26:00 = 0°

FIGURE 4: FUEL INVENTORY (from Brown (1974).

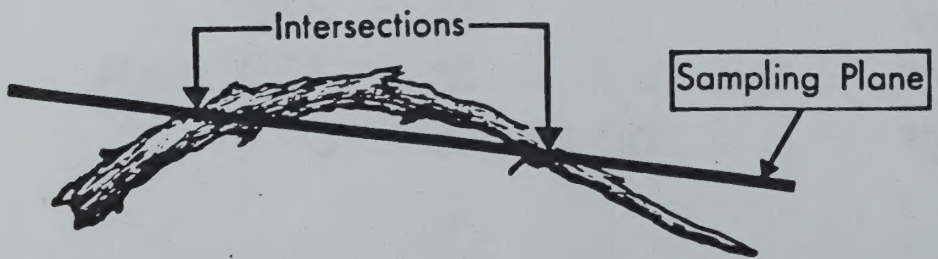


The sampling plane is the verticle plane defined by the tape

◎ Intersections where diameters are measured

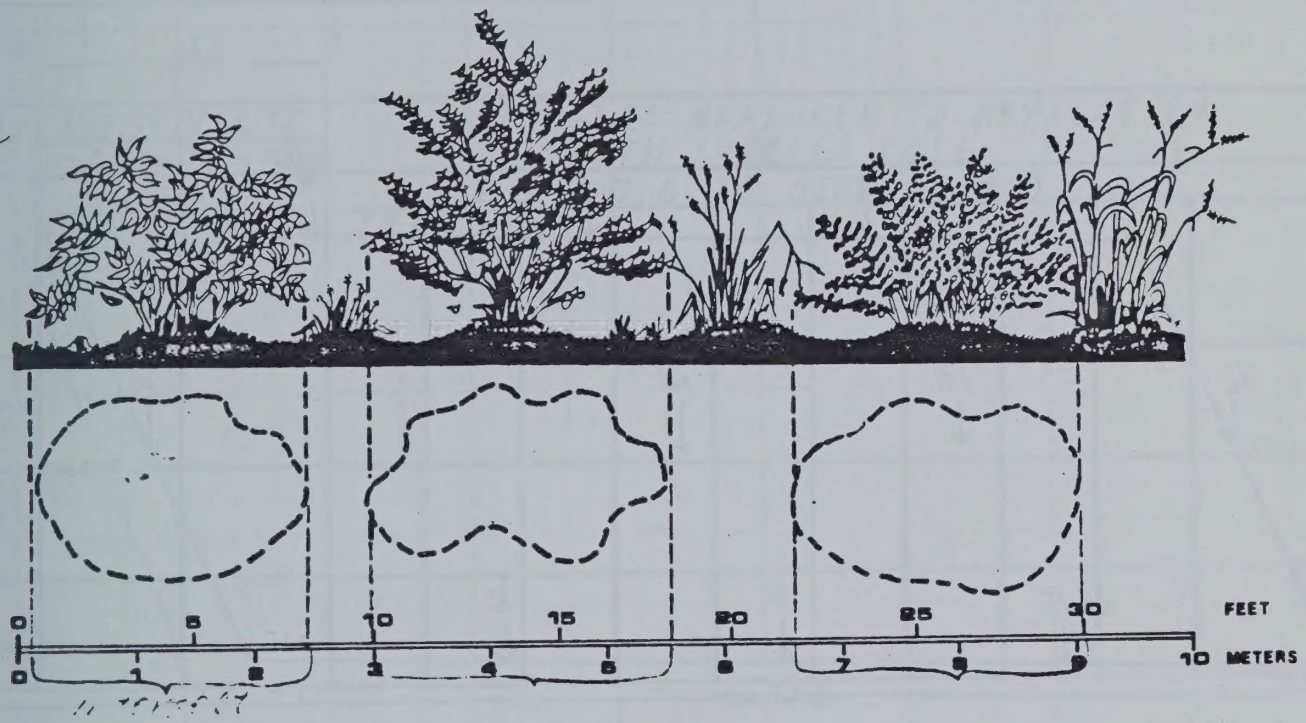


An intersection at the end of a branch or log must include the central axis to be tallied.



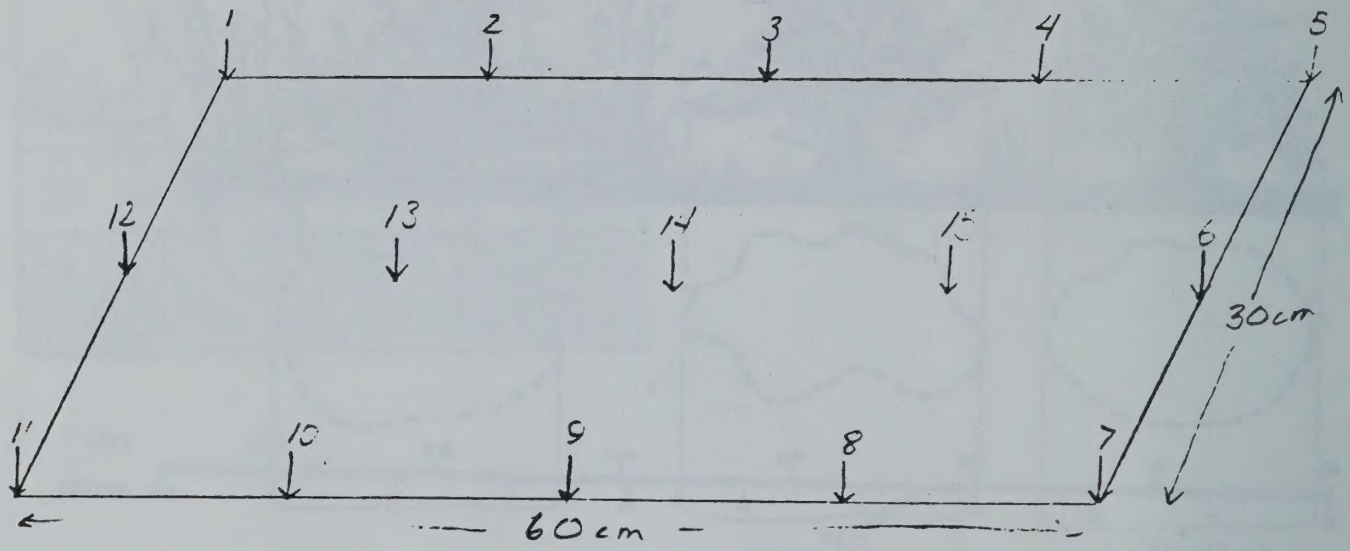
Count both intersections for a curved piece.

FIGURE 5: LINE INTERSECT SAMPLING OF SHRUBS.
(from Chambers and Brown (1983))



Record 0.1, 2.5 / 3.0, 5.5 / 5.5, 9.1 as the intercept = I_1 & I_2

FIGURE 6: MEASURING DUFF DEPTH OF QUADRAT



measure depth to nearest mm at 15 locations as duff samples are removed

FUEL INVENTORY

DISTRICT _____ UNIT _____ BURN __ NOBURN __

PREBURN __ POSTBURN __ YEAR 1 __ YEAR 2 __ YEAR 5 __

OBSERVERS _____ DATE _____ DECLINATION ____

PLOT # ____ AZ ____°

TRANSECT	PIECE COUNTS 0-2.5cm	PIECE COUNTS 2.5-7.6cm	DIAMETERS MEASURED TO NEAREST CM WITH SPECIES CODE (2.5 - 7.6 TO NEAREST MM) (7.6+)											
AZ														
AZ+90°														
AZ+180°														
AZ+270°														

____ AZ ____°

TRANSECT	PIECE COUNTS 0-2.5cm	PIECE COUNTS 2.5-7.6cm	DIAMETERS MEASURED TO NEAREST CM WITH SPECIES CODE (2.5 - 7.6 TO NEAREST MM) (7.6+)											
AZ														
AZ+90°														
AZ+180°														
AZ+270°														

SPECIES CODES:
D-DOUGLAS FIR, T-TRUE FIR, H-HEMLOCK, C-CEDAR, R-ROTTEN LOG
A-ALDER, V-VINE MAPLE, M-BIG LEAF MAPLE, O-OTHER

SHRUB INVENTORY

DISTRICT _____ UNIT _____ BURN ___ WOBURN ___

PREBURN ___ POSTBURN ___ YEAR 1 ___ YEAR 2 ___ YEAR 5 ___

OBSERVERS _____ DATE _____ DECLINATION _____

PLOT # ___ AZ ___°

TRANSECT	POINTS OF INTERSECTION (TO NEAREST DM) AND SPECIES								
	I_1	I_2	SPECIES	I_1	I_2	SPECIES	I_1	I_2	SPECIES
AZ									
AZ+90°									
AZ+180°									
AZ+270°									

PLOT # ___ AZ ___°

TRANSECT	POINTS OF INTERSECTION (TO NEAREST DM) AND SPECIES								
	I_1	I_2	SPECIES	I_1	I_2	SPECIES	I_1	I_2	SPECIES
AZ									
AZ+90°									
AZ+180°									
AZ+270°									

DUFF DEPTHS

DISTRICT _____ UNIT _____ BURN ___ NO BURN ___

PREBURN ___ POSTBURN ___ YEAR 1 ___ YEAR 2 ___ YEAR 5 ___

PLOT	DEPTH TO NEAREST MM															COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1																
2																
3																
4																
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SOIL EXPOSURE INVENTORY

DISTRICT _____ UNIT _____ BURN ___ NO BURN ___

PREBURN ___ YEAR 1 ___ YEAR 2 ___ YEAR 5 ___

PLOT	AZ*	% SLOPE	INTERCEPTS (0.1m) OF MINERAL SOIL EXPOSURE											
			I_1	I_2	I_1	I_2	I_1	I_2	I_1	I_2	I_1	I_2	I_1	I_2

* START NEW LINE FOR EACH AZ and PLOT.

Appendix: Soil sampling procedure

Soil samples from plots 1-3, 4-6, etc., for each depth are combined to reduce analytical costs. This compositing should be done in the field to avoid logistical problems of numbering and transporting a large number of samples.

For efficiency and to minimize site disturbance, soil samples should be taken as cores whenever possible. Core samples also help insure that equal volumes of soil are included from each of the 12 points being composited (3 plots x 4 transects/plot X 1 point/transect).

If a shovel must be used because of large quantities of coarse fragments, the pits should be very small. All soil removed from the pit should be saved in a large bucket or on canvas. This soil can then be poured back into the hold after the sample for nitrogen analysis has been removed. Using the bucket or canvas will prevent the soil from contaminating the fuels or points where future samples will be taken.

Tools needed for core sampling:

6+ 2" dia. thin-walled, electrical conduit. (A 10 ft. section (approximately $12) cut with a pipe cutter into 20" lengths. A pipe cutter leaves a compressed end which can easily be sharpened.)

Half-round file - 8". (Used to sharpen tube and smooth damage to cutting edge.)

Hand sledge, 3 pound (Heavier hammer or hard driving causes

excess damage to tube.)

3 1 gallon paint pails with bail. (Use to transport soil between plots and mixing the composite sample before subsampling for analysis.)

Bench grinder - optional. (Speeds sharpening of tubes.)

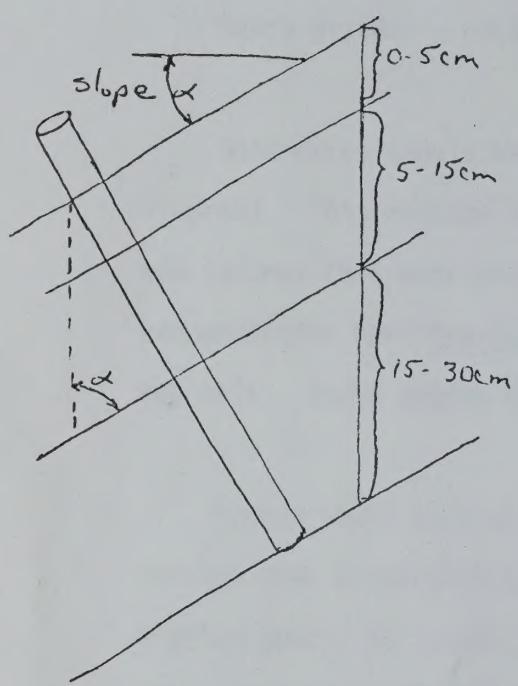
Soil cores should be taken perpendicular to the soil surface (see diagram). This reduces the depth to which the core sampler must be driven and insures that each sample is a parallel layer of soil. The perpendicular sampling depth can be calculated using the average slope of the unit. These depths are marked on the outside of the tube with a file.

From a small area around each sample point, litter and duff are removed down to mineral soil. The tube is driven to the 5 cm depth mark, wiggled gently to loosen, and carefully removed so that very little soil rolls into the hole. The tube is emptied into the pail marked for the 0-5 cm depth and returned to the hole. Repeat for each depth. A knife, long screwdriver, or other tool may be needed to completely remove the soil from the tube.

When all 12 samples for each depth have been collected, each sample is mixed thoroughly. Large, coarse fragments are discarded at this time. A soil sample bag of the remaining soil is saved for analysis and the rest is discarded. The soil placed in the bag must be representative of all the soil in the bucket. Information on the bag should include the site, plot number, date, and depths.

Soil samples must be air dried immediately. The samples should be removed from the sample bag and spread on paper to dry the same day that they are collected. The bag numbers should be written on each paper in case they become mixed up.

Adjusting soil sampling depth for slope when soils are removed with tubes driven perpendicular to the soil surface.

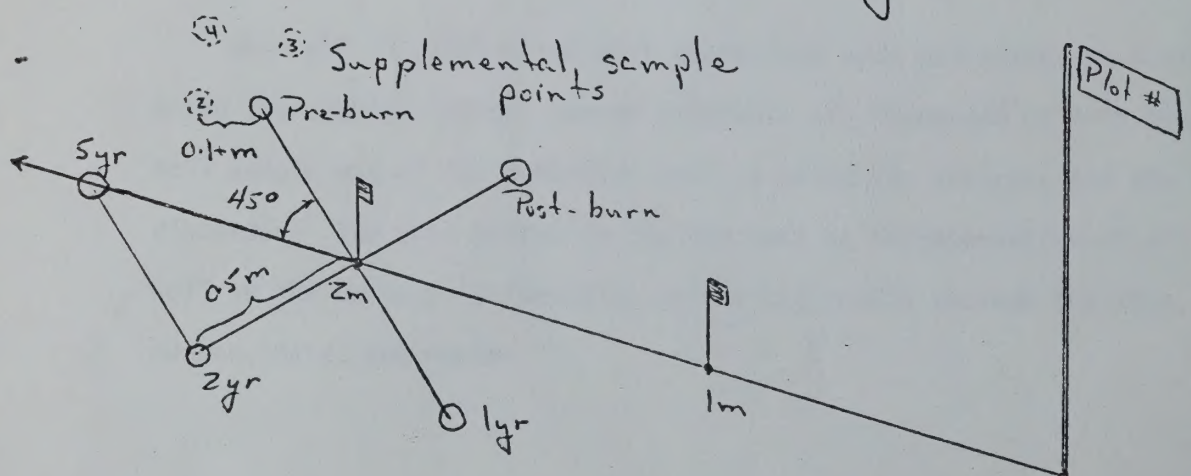


$$\text{Slope (degrees)} = \tan\left(\frac{\text{slope \%}}{100}\right)$$

$$\perp \text{ Driving depth} = \cos(\text{slope, degrees}) \times \text{Vertical depth}$$

Example: Average slope of 60%

$$\text{Slope, }^\circ = \tan(60/100) \approx 31^\circ$$

$$\perp \text{Depth} = (\cos 31^\circ)(5\text{-}15\text{ cm}) = 0.86\ (5\text{-}15) = 4.29 - 12.86\text{ cm}$$

Soil Sample locations along each transect